

19

$\text{Na}_2\text{WO}_4$ ,  $\text{In}_2\text{CdO}_4$ ,  $\text{LiAlO}_2$ ,  $\text{LiGaO}_2$ ,  $\text{Ca}_8\text{La}_2(\text{PO}_4)_6\text{O}_2$ , lithium aluminate, gallium arsenide, silicon, germanium, or a silicon-germanium alloy.

4. The method of claim 2 wherein the thermal process causes formation of a substantially homogeneous region of crystalline material within a vicinity of a surface region of the sandwiched structure.

5. The method of claim 2 further comprising n thicknesses of material overlying the third thickness of material, where n is at least 10.

6. The method of claim 2 further comprising forming at least two of the thicknesses of material using an HPVE process comprising at least two different sources of group III metals.

7. The method of claim 2 wherein the forming of the first thickness of material comprising flowing a first halogen-containing gas over a first group III metal and wherein the forming of the second thickness of material comprises flowing a second halogen-containing gas over a second group III metal; and rotating a susceptor that is proximate to the substrate to cause sequential exposures to the first group III metal and the second group III metal.

8. The method of claim 2 wherein the first thickness of material is formed in a first zone and the second thickness of material is formed in a second zone.

9. The method of claim 2 wherein the forming of the first thickness of material comprises flowing a first alternating sequence comprising a first halogen-containing gas and a first carrier gas over a first group III metal and wherein the forming of the second thickness of material comprises flowing a second alternating sequence comprising a second halogen-containing gas and a second carrier gas over a second group III metal; and controlling the timing of the first alternating sequence and the second alternating sequence so as to cause sequential exposures to the first group III metal and the second group III metal.

10. The method of claim 2 wherein the first thickness of material, the second thickness of material, and the third thickness of material are formed in a sequential and continuous manner.

11. The method of claim 2 further comprising providing a heating element within a vicinity of the surface region.

12. The method of claim 11 wherein the heating element is characterized by a temperature ranging from about 500 to about 2000 Degrees Celsius.

13. The method of claim 12 wherein the heating element is configured to increase a reaction rate of forming at least the first thickness of material.

14. The method of claim 2 wherein the first thickness of material comprises indium and nitrogen containing species; and the second thickness of material comprises a gallium and nitrogen containing species.

20

15. The method of claim 2 wherein the forming of the first thickness of material comprises a process selected from an electron bombardment process, a dc plasma process, an rf plasma process, or a microwave plasma process.

16. The method of claim 2 wherein the first thickness of material consists of a first mono-layer and the second thickness of material consists of a second mono-layer.

17. The method of claim 2 wherein the first thickness of material, the second thickness of material, and the third thickness of material are deposited by molecular beam epitaxy.

18. The method of claim 2 wherein the first thickness of material, the second thickness of material, and the third thickness of material are deposited by metalorganic chemical vapor deposition.

19. The method of claim 18 wherein at least two metalorganic precursor sources are introduced via separate chambers in a showerhead that is proximate to the substrate.

20. An indium, gallium and nitrogen containing substrate structure comprising:

a substrate having a surface region;

a first thickness of material having a first indium-rich concentration;

a second thickness of material having a first indium-poor concentration overlying the first thickness of material; and

a third thickness of material having a second indium-rich concentration overlying the second thickness of material to form a sandwiched structure comprising at least the first thickness of material, the second thickness of material, and third thickness of material; wherein

the sandwiched structure comprises well-crystallized, relaxed material within a vicinity of a surface region of the sandwiched structure; and

the sandwiched structure has an overall thickness of 100 nm or greater.

21. The method of claim 1, wherein the material having an indium-poor concentration comprises one or more of GaN, AlN, AlGaIn, or a material having less than 5% InN.

22. The method of claim 1, wherein the material having an indium-poor concentration comprises  $\text{In}_y\text{Ga}_{1-y}\text{N}$  or  $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$ , wherein  $0 \leq x \leq 1$  and  $0 < y, x+y < 1$ , and y is less than 0.05.

23. The method of claim 1, wherein the material having an indium-rich concentration comprises one or more of InN, GaN, AlN, AlGaIn, or a material having greater than 5% InN.

24. The method of claim 1, wherein the material having an indium-poor concentration comprises  $\text{In}_y\text{Ga}_{1-y}\text{N}$  or  $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$ , wherein  $0 \leq x \leq 1$  and  $0 < y, x+y < 1$ , and y is greater than 0.05.

\* \* \* \* \*